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## CLEAN VERSION OF CLAIMS

## CLAIMS

- 1    1.    An apparatus adapted for seismic data acquisition in a land or transition  
2        zone environment, said apparatus comprising:  
3        a positioning device;  
4        a seismic sensor, capable of being placed near said positioning device;  
5        and  
6        means for determining the distance between said seismic sensor and said  
7        positioning device using an airborne acoustic transmission between said  
8        positioning device and said seismic sensor.
  
- 1    2.    An apparatus as claimed in claim 1, in which said airborne acoustic  
2        transmission is produced by a speaker at said positioning device and  
3        received by a microphone at said seismic sensor.
  
- 1    3.    An apparatus as claimed in claim 2, in which said airborne acoustic  
2        transmission received by said microphone at said seismic sensor is  
3        converted from analog to digital format using an analog to digital  
4        converter that is also used to convert seismic signals received by said  
5        seismic sensor from analog to digital format.

- 1    4.    An apparatus as claimed in either claim 2 or claim 3, in which said  
2        airborne acoustic transmission received by said microphone at said  
3        seismic sensor is transmitted using a cable that is also used to transmit  
4        seismic data received by said seismic sensor.
  
- 1    5.    An apparatus as claimed in any one of claims 1 to 4, in which said  
2        airborne acoustic transmission is a spread spectrum acoustic signal.
  
- 1    6.    An apparatus as claimed in any one of claims 1 to 5, in which said  
2        airborne acoustic transmission is a pulse, frequency sweep, or digitally  
3        encoded sweep acoustic signal.
  
- 1    7.    An apparatus as claimed in any one of claims 1 to 6, in which said  
2        airborne acoustic transmission is generated by signal generation circuitry  
3        that is also used to test said seismic sensor.
  
- 1    8.    An apparatus as claimed in any one of claims 1 to 7, further including a  
2        temperature sensor for measuring the temperature of the air near said  
3        seismic sensor or said positioning device.
  
- 1    9.    An apparatus as claimed in any one of claims 1 to 8, further including a  
2        survey flag and wherein said positioning device is placed near said  
3        survey flag.

1 10. An apparatus as claimed in any one of claims 1 to 9, in which said  
2 positioning device is a first positioning device and further including a  
3 second positioning device and means for determining the distance  
4 between said second positioning device and said seismic sensor using an  
5 airborne acoustic transmission between said second positioning device  
6 and said seismic sensor.

1 11. An apparatus as claimed in claim 10, further including means for  
2 determining the distance between said first positioning device and said  
3 second positioning device.

1 12. An apparatus as claimed in claim 11, in which said means for  
2 determining the distance between said first positioning device and said  
3 second positioning device uses an airborne acoustic transmission  
4 between said first positioning device and said second positioning device.

1 13. An apparatus as claimed in any one of claims 10 to 12, in which said first  
2 positioning device and said second positioning device are connected by a  
3 cable.

1 14. An apparatus as claimed in any one of claims 10 to 13, in which said  
2 second positioning device is placed at a predetermined azimuthal  
3 orientation with respect to said first positioning device.

1 15. An apparatus as claimed in any one of claims 10 to 14, further including  
2 means for confirming that said second positioning device has been placed  
3 at a predetermined azimuthal orientation with respect to said first  
4 positioning device.

1 16. An apparatus as claimed in any one of claims 10 to 15, in which a  
2 seismic source signal is used to determine to resolve the line symmetry  
3 ambiguity when determining the position of said seismic sensor with  
4 respect to said first positioning device and said second positioning  
5 device.

1 17. An apparatus as claimed in claim any one of claims 1 to 16, wherein said  
2 seismic sensor is a first seismic sensor and further including additional  
3 seismic sensors and means for determining the distance between said  
4 additional seismic sensors and said positioning device using airborne  
5 acoustic transmission between said positioning device and said additional  
6 seismic sensors.

1 18. An apparatus as claimed in claim 17, further including means for  
2 calculating a group center of gravity for said first seismic sensor and said  
3 additional seismic sensors.

1 19. An apparatus as claimed in claim 17, further including means for  
2 determining whether said first seismic sensor and said additional seismic  
3 sensors have been laid out in a prescribed order.

1 20. An apparatus as claimed in any one of claims 1 to 19, in which said  
2 seismic sensor and said positioning device are located at a first seismic  
3 station and further including an additional positioning device located at a  
4 second seismic station and means for determining the distance between a  
5 device located at said first seismic station and a device located at said  
6 second seismic station.

1 21. A method of determining the position of a seismic sensor adapted for  
2 seismic data acquisition in a land or transition zone environment, said  
3 method comprising the steps of:  
4 placing a positioning device in a particular location;  
5 placing a seismic sensor near said positioning device; and  
6 determining the distance between said seismic sensor and said  
7 positioning device using an airborne acoustic transmission between said  
8 positioning device and said seismic sensor.

1 22. A method as claimed in claim 21, in which said airborne acoustic  
2 transmission is produced by a speaker at said positioning device and  
3 received by a microphone at said seismic sensor.

- 1 23. A method as claimed in claim 22, in which said airborne acoustic  
2 transmission received by said microphone at said seismic sensor is  
3 converted from analog to digital format using an analog to digital  
4 converter that is also used to convert seismic signals received by said  
5 seismic sensor from analog to digital format.
- 1 24. A method as claimed in either claim 22 or claim 23, in which said  
2 airborne acoustic transmission received by said microphone at said  
3 seismic sensor is transmitted using a cable that is also used to transmit  
4 seismic data received by said seismic sensor.
- 1 25. A method as claimed in any one of claims 21 to 24, in which said  
2 airborne acoustic transmission is a spread spectrum acoustic signal.
- 1 26. A method as claimed in any one of claims 21 to 25, in which said  
2 airborne acoustic transmission is a pulse, frequency sweep, or digitally  
3 encoded sweep acoustic signal.
- 1 27. A method as claimed in any one of claims 21 to 26, in which said  
2 airborne acoustic transmission is generated by signal generation circuitry  
3 that is also used to test said seismic sensor.

1 28. A method as claimed in any one of claims 21 to 27, further including the  
2 step of measuring the temperature of the air near said seismic sensor or  
3 said positioning device.

1 29. A method as claimed in any one of claims 21 to 28, in which said  
2 positioning device is placed near a survey flag.

1 30. A method as claimed in any one of claims 21 to 29, in which said  
2 positioning device is a first positioning device and further including the  
3 step of determining the distance between a second positioning device and  
4 said seismic sensor using an airborne acoustic transmission between said  
5 second positioning device and said seismic sensor.

1 31. A method as claimed in claim 30, further including the step of  
2 determining the distance between said first positioning device and said  
3 second positioning device.

1 32. A method as claimed in claim 31, in which said step of determining the  
2 distance between said first positioning device and said second  
3 positioning device uses an airborne acoustic transmission between said  
4 first positioning device and said second positioning device.



1 33. A method as claimed in any one of claims 30 to 32, in which said first  
2 positioning device and said second positioning device are connected by a  
3 cable.

1 34. A method as claimed in any one of claims 30 to 33, in which said second  
2 positioning device is placed at a predetermined azimuthal orientation  
3 with respect to said first positioning device.

1 35. A method as claimed in any one of claims 30 to 34, further including the  
2 step of confirming that said second positioning device has been placed at  
3 a predetermined azimuthal orientation with respect to said first  
4 positioning device.

1 36. A method as claimed in any one of claims 30 to 35, in which a seismic  
2 source signal is used to determine to resolve the line symmetry ambiguity  
3 when determining the position of said seismic sensor with respect to said  
4 first positioning device and said second positioning device.

1 37. A method as claimed in any one of claims 21 to 35, wherein said seismic  
2 sensor is a first seismic sensor and further including additional seismic  
3 sensors and the step of determining the distance between said additional  
4 seismic sensors and said positioning device using airborne acoustic

5 transmissions between said positioning device and said additional  
6 seismic sensors.

1 38. A method as claimed in claim 37, further including the step of calculating  
2 a group center of gravity for said first seismic sensor and said additional  
3 seismic sensors.

1 39. A method as claimed in claim 37, further including the step of  
2 determining whether said first seismic sensor and said additional seismic  
3 sensors have been laid out in a prescribed order.

1 40. A method as claimed in any one of claims 21 to 39, in which said seismic  
2 sensor and said positioning device are located at a first seismic station  
3 and further including an additional positioning device located at a second  
4 seismic station and the step of determining the distance between a device  
5 located at said first seismic station and a device located at said second  
6 seismic station.

1 41. A method as claimed in any one of claims 21 to 40, further including the  
2 steps of recording seismic data acquired by said seismic sensor and  
3 assigning sensor position coordinates to said seismic data based on said  
4 distance between said seismic sensor and said positioning device.

1 42. A method as claimed in any one of claims 21 to 41, further including the  
2 step of calculating a deviation between actual seismic sensor position  
3 coordinates and planned seismic sensor position coordinates.

1 43. A method as claimed in claim 42, further including the step of  
2 compensating for said deviation between said actual seismic sensor  
3 position coordinates and said planned seismic sensor position  
4 coordinates.

1 44. A method as claimed in claim 43, in which said compensation step  
2 includes mathematically moving a group center of gravity from an actual  
3 position to a planned position.

1 45. A method as claimed in claim 44, in which said compensation step  
2 includes bypassing a digital ground roll removal process.